Cellulose Biosynthesis in Arabidopsis

The observations reported by Tony Arioli et al. (1) represent an important contribution to characterizing the complex processes of biogenesis of cellulose in higher plants. The results presented and further discussed by Carpita and Vergara (2) do not exclude alternative interpretations consistent with the observations. The alternatives are suggested by the occurrence of significant amounts of a soluble β-1,4-linked glucan in the instances wherein the action of the cellulose synthase was perturbed by growth at 31°C. The celloligosaccharides are known to become insoluble at the octamer (3). Furthermore, substitution at a single hydroxyl of one in ten anhydroglucose units can make cellulose soluble in neutral aqueous media. Observations of a soluble β-1,4-linked glucan led Colvin to propose, in 1974, that Acetobacter xylinum can produce a “soluble cellulose” (4). Permethylation analyses later showed low levels of β-1,2-linked glucose units along the chain. Arioli et al. may be observing a similar gluco-glucan of limited substitution. The occurrence of such a glucan would not be detected in the hydrolysis-based analyses usually applied to cell wall polysaccharides, and the permethylation analysis described by Arioli et al. is focused on excluding the β-1,3-linked callose, which is frequently observed when cellulose synthase activity is disrupted.

Two alternative interpretations of the soluble β-1,4-linked glucan suggest themselves. First, the mutant could have a synthase of limited stability, that can have its specificity for β-1,4 glycosylation perturbed enough at 31°C to result in occasional nonspecific linkages, resulting in a gluco-glucan with substitution sufficient to make it soluble. Second, the soluble glucan could be a precursor to cellulose that is stripped of its substituents under normal conditions, a process that could be disrupted at 31°C in the mutant (5).

Careful permethylation analyses of the soluble β-1,4-linked glucan, with particular attention to minor components, will be important to full development of the implications of the observations made by Arioli et al. (1).

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